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Evidences of the fractional kinetics in temperature region: Evolution of extreme points in ibuprofen

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ABSTRACT

Based on a new approach presented in detail in this paper one can find new evidences of existence of the fractional kinetics not only in the frequency range. One can find rather general principles of detection of different collective motions in temperature region. These principles can be expressed in terms of an algorithm (defined in the paper as an approach). This approach includes some steps that help to separate a couple of the neighboring collective motions (expressed in the frequency range as a linear combination of two power-law exponents) from each other and establish the temperature evolution of the extreme point that follows to the generalized Vogel–Fulcher–Tamman (VFT)-equation. This experimentally confirmed fact gives new evidences for supporting of the theory of dielectric relaxation based on the fractional kinetics on the frequency/temperature domain. As an example for verification of this new approach the ibuprofen complex permittivity data measured in the wide frequency/temperature range were chosen. The reason of such selection was the following. It helps to compare the conventional study of this complex substance recently published in [1] and use possibilities of the developed approach that can add some new features to the picture obtained in the frame of the conventional treatment. We suppose that possibilities presented by new approach will be extremely useful for detection of different collective motions in other substances studied by the method of broadband dielectric spectroscopy (BDS).

1. Introduction and formulation of the problem

Many years dielectric spectroscopy (DS) related to measurements of the complex permittivity $\varepsilon(j\omega)$ and impedance $Z(j\omega)$ was considered as a pure empirical *method* in comparison with possibilities of the electronic/nuclear magnetic resonance measurements and thereby was ignored by many serious researches. But nowadays thanks to development of the fractal geometry and establishing of definite relationships of the fractal geometry with the fractional calculus [2,3] new possibilities of understanding of the proper place of broadband dielectric spectra (BDS) are appeared. Recently some general principles of analysis of dielectric spectra [4] in the frame of the fractional kinetics were outlined in papers of one of the authors (RRN).

In this paper we shall try to apply new approach to treatment of DS data (ibuprofen complex permittivity data in our case) in order to show new possibilities in comparison with the conventional treatment of data. Novel approach that is discussed in this paper helps to analyze not only wide frequency band. It helps to *track* the temperature evolution of an extreme (minimal or maximal) point that is appeared in the complex permittivity $\varepsilon(j\omega)$ spectrum in the beginning of available low-fre-

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